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Impact of a new exhibit on stereotypic behaviour in an elderly captive African elephant *(Loxodonta africana).*

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Abstract

Stereotypic behaviour in zoo elephants is considered an indicator of impaired welfare. The underlying causes are diverse and many aspects are still unexplored. Nevertheless, many zoological institutions make huge efforts to improve the well-being of their elephants. The construction of a new exhibit provides a chance to gain further evidence on the impact of such measures on elephant behaviour. We report a significant decrease in both the amount and frequency of swaying in an elderly African elephant (*Loxodonta africana*) after transition to a new enclosure. While we assume that continuous social interactions, increased freedom of choice and appropriate resting locations were critical for the distinct improvement of this individual´s well-being, the only factor that significantly correlated with swaying in this individual was the amount of time per day the elephant group was separated. Thus, corresponding adaptations in elephant husbandry are also encouraged in facilities without resources for the building of extensive new exhibits and may lead to increased zoo elephant welfare.

Introduction

Stereotypical behaviour, especially in the manner of swaying, is quite common in captive elephants (Greco et al. 2017; Greco et al. 2016). Stereotyping is generally defined as functionless repetitive behaviour, independent of the underlying cause and situation of its occurrence (Mason 1991; Mason and Veasey 2010). This unnatural repetitive behaviour has been documented in semi-captive elephants living in countries of origin, as well as in North American and European zoos (Clubb and Mason 2002; Greco et al. 2016; Kurt and Garai 2001). In extreme cases, elephants have been reported to spend up to 66% of their time exhibiting stereotypic behaviours (Kurt and Garai 2001; Meller et al. 2007). Nevertheless, research on the causal factors of this behaviour (Greco et al. 2017). Correlation with indicators of stress and poor health have been confirmed (Haspeslagh et al. 2013; Kurt and Garai 2001) and stereotypic behaviour is widely considered a sign of impaired welfare (Asher et al. 2015; Mason and Veasey 2010). A recent assessment of the North American zoo elephant population identified spending time housed separately, history of inter-institutional transfers, unsuccessful breeding and being a member of a non-breeding group of mainly unrelated females as risk factors for the occurrence of stereotypic behaviour (Greco et al. 2016). African elephants are generally considered to express less stereotypies than their Asian counterparts (Greco et al. 2016).

Modern zoos undertake huge efforts in rebuilding enlarged enclosures and for optimisation of husbandry methods, directed at further improving their elephant management and care. Ideally, these actions lead to an increase in natural behaviour, while unnatural behaviours, including stereotyping, decrease (Soltis and Brown 2010). Looking at the scarcity of

Table 1. Comparison of technical data from the old and new African elephant exhibit at Zoo Basel.

Feature (m^2)	Old exhibit (1952–2015)	New exhibit (opened in March 2017)
Outdoor area bull	450	1,010
Outdoor area cows	1,300	3,283
Indoor area bull	36.2	289
Indoor area cows	188	671
Total area	1,974.2	5,253
Management system	Free contact (females) and Protected contact (male, since 02/08/1984)	Protected contact (females and male) since 03/08/2016

Figure 1. Comparison of the old and new African elephant exhibit at Zoo Basel. Old indoor (a) and outdoor (b) exhibit during the first period of observation and both areas of the new exhibit (c,d) during period 4 and 5 of observation.

evidence by specific reports (Braidwood 2013; Jacobs 2011; Lucas and Stanyon 2016; Thomas et al. 2001), uncertainties concerning the expectable effects of a new exhibit on stereotypic behaviour of an elephant remain. The present case report aims to (I) document changes in the amount of swaying in an elderly female African elephant (*Loxodonta africana*) during and after the reconstruction of a new elephant exhibit at Zoo Basel. Additionally, (II) potential influencing factors were assessed to identify parameters that might be most critical. Ideally, consideration of these parameters may provide further helpful advice to elephant-keeping facilities in optimising their husbandry conditions.

Material and methods

Site and focus subject

The study was conducted at Zoo Basel, Switzerland from April 2015 until September 2017. The observations covered the construction process of a new elephant exhibit and the transfer of the elephant group to their new environment. Relevant features of the old and new elephant exhibit, which was constructed on the area of the old exhibit, are summarised in Table 1 and impressions shown in Figure 1. The main goal of the new exhibit in terms of elephant husbandry was the facilitation of natural elephant behaviour with diversified feeding (a great number of feeding enrichment

Table 2. Overview on the time frame, exhibit availability and husbandry characteristics during the five observation periods.

Period of observation	Time frame	Exhibit available	Social conditions	Further remarks
1	03/04–25/04/2015	Old exhibit indoor and outdoor. Gates closed during the night on day 1 and open on days 2+3.	Elephants separated into two pairs when confined to the indoor area.	Free contact
2	11/12–23/12/2015	Old exhibit indoor, new male exhibit outdoor. Gates closed during the night.	Elephants separated into two pairs when confined to the indoor area.	Free contact
3	24/02–24/03/2016	New male exhibit indoor and outdoor. Gates closed during the night.	Elephants separated only for training sessions and individual feeding.	Free contact
4	05/04–28/04/2017	New exhibit indoor and outdoor. Gates closed during the night.	Elephants separated only for training sessions and individual feeding.	Protected contact
5	19/08–10/09/2017	New exhibit indoor and outdoor. Gates open during the night.	Elephants separated only for training sessions and individual feeding. Male irregularly with the herd, depending on sexual cycle of the females.	Protected contact

Table 3. Detailed data on a 44 year old female African elephant´s stereotypical swaying behaviour during 15 days (24 h) of observation.

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
bouts per day	27	11	12	39	22	18	4	5	6	11	12	6	15	4	0
average duration per bout [min]	14.89	13	15	25.38	26.82	41.56	1.75	1.6	41.17	13.27	5.25	3.17	9.67	5	0
total duration per day [min]	402	143	180	990	590	748	7	8	247	146	63	19	145	20	0
total duration while free access indoor + outdoor [min]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
time of confinement to the indoor exhibit [min]	1022	31	98	1205	1049	1083	1239	1233	1107	993	1076	1189	117	168	192
time of confinement to the outdoor exhibit [min]	228	500	443	235	391	357	201	207	293	447	364	82	398	398	266
time with free access to the indoor and outdoor exhibit [min]	190	909	899	0	0	0	0	0	40	0	0	169	925	874	982
time of separation of the group [min]	1022	31	98	1205	1049	1083	38	7	19	44	14	13	55	0	86
average ambient temperature [°C]*	5.8	14.9	14.4	3.9	6.9	7.6	2.2	3.7	6.0	11.3	13.4	3.9	18.0	24.3	13.5

*data for ambient temperature were taken from the online resource http://www.klimabasel.ch/daten.htm (access on the 07/12/2017)

devices scattered all over the exhibit e.g. hay/straw nets, various top-feeders and feeding holes), locomotion and social interactions (Hoby and Baumeyer 2017). Moreover, the concept of the new elephant enclosure was to provide free access to various indoor and outdoor areas whenever weather conditions allowed, and to avoid separation of females during night time and thus encourage cohesion between the elephants (Hoby and Baumeyer 2017). Although it was intended to establish a breeding group, the new male elephant arrived only in May 2017 due to a lack of space during the construction period. Subject of the observation was a group of four unrelated female African elephants ranging in age from 20 to 44 years. The two younger females are assumed to originate from the same herd and to have a degree of kinship (Hüppi 2014). Focus was laid on the oldest elephant in the group. This particular elephant was supposedly wild-born in Tanzania in 1971. Before her arrival at Zoo Basel on 30th November 1984, she lived in a Swiss Circus since her importation in 1974. Several years after her transfer to the zoo, she became pregnant and had a stillbirth of a mature calf in 1992. She had no further pregnancy since then. According to the elephant keepers, the female elephant showed regular swaying since her arrival at Zoo Basel in 1984, whereas other individuals in the herd did not show any stereotypic behaviour (personal communication).

Data collection

According to the different steps of reconstruction, data collection was divided into five observation periods. Detailed information on the circumstances during the different periods is given in Table 2. During each period, three full days of direct observation by one observer watching the elephants continuously for 24 subsequent hours on site (all performed by the first author) were conducted with an interval of 3 to 21 days. Lights of the nearby city, as well as a faint nightlight with which the elephants were familiar, allowed identification of individual behaviours during the night. This approach resulted in a total observation time of 72 hours per period. A camera system was not permanently in place and could not guarantee visualisation of every elephant at every point in time. Data were collected by instantaneous scan sampling at an interval of 5 minutes (Altmann 1974). A simple ethogram consisting of nine categories (see Appendix) was applied, and the observed categories were noted manually on a data sheet. Additionally, stereotypic behaviour and lying rest were recorded by continuous sampling, accurate to the minute (Altmann 1974). The end of a stereotyping bout was noted if the elephant stopped swaying for at least 30 seconds. If two activities (e.g. foraging and walking) occurred simultaneously, the more dominant one was recorded. Moreover, moments of management actions, such as feeding, closing/opening of gates and interaction

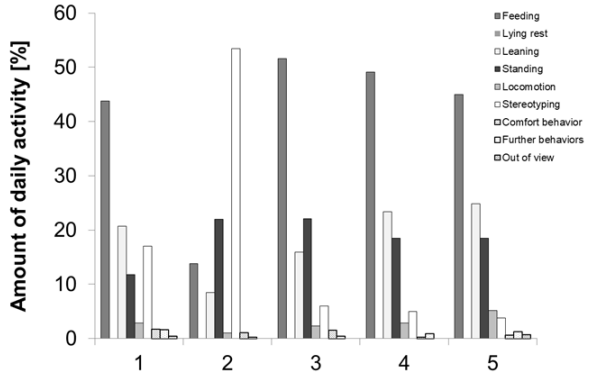

Figure 2. Activity budgets of a female African elephant during the five periods of observation.

Table 4. Correlations between various behaviours of a female African elephant assessed by Spearman's correlation coefficient.

	Feed	Rest (total)	Rest (standing)	Rest (leaning)	Locomotion
Stereotyping	R=-0.76	R=-0.82	R=-0.13	R=-0.62	R=-0.56
	P=0.001	P>0.001	P=0.657	P=0.013	P=0.028
Feed		R=0.42	R=-0.14	R=0.48	R=0.43
		P=0.120	P=0.629	P=0.073	P=0.109
Rest (standing)		R=0.43		R=-0.47	R=-0.32
		P=0.114		P=0.076	P=0.247
Rest (leaning)		R=0.51			R=0.79
		P=0.052			P=0.001

with keepers, were recorded. Ambient temperature data for the observation days were extracted from an online resource (http://www.klimabasel.ch/daten.htm; access on 07.12.2017).

Statistics

Data were generally not normally distributed (as assessed by Kolmogorov-Smirnov test) and, therefore, nonparametric statistics were used. Correlations between various behaviours were assessed by Spearman's correlation coefficient, and differences between observation periods were assessed by Kruskal-Wallis test. Additionally, in order to assess the two factors considered most influential for swaying (the time the group members were separated, and the time access was confined to specific parts of the enclosure), a General Linear Model (GLM) was used (with residuals showing a normal distribution) with the proportion of time spent stereotyping as the dependent variable, and the time with access to all enclosure components (indoor and outdoor) and the time the whole group was allowed together as independent variables. The level of significance was set at a P-value <0.05.

Results

Instantaneous scan sampling during the five observation periods (15 × 24 hours) resulted in a total of 4,310 successful (= behaviour unambiguously identifiable) scans out of 4,320 possible scans for the focus elephant. This means a success rate of 99.77%. During observations, a total of 192 swaying bouts were recorded with a total duration of 3,708 min (mean 19.3 min, SD±26.2 min, median 5 min, range 1–126 min) and a daily average of 247.2 min (SD±304.0 min, median 201 min, range 0–990 min) (Table 3). The latter corresponded to an amount of 17.17% of the total observation time. The female elephant showed stereotypic behaviour exclusively in the form of stationary whole-body movements from side to side, which was termed swaying or weaving (Greco et al. 2017). Supplemental material provided a video sequence of this behaviour (Video S1). The number of bouts and daily duration of swaying varied between the different observation periods (Figure 2). Highest values were recorded in Period 2, and lowest in Periods 3 and 5 (Figure 2). On the last day of observation (day 15) not a single bout of swaying was recorded. The proportion of time spent swaying differed significantly between the five periods (P=0.043). The focus elephant showed swaying exclusively during periods when access was restricted either to the outdoor or indoor area, independent of observation period and area available. No single bout of swaying was recorded when the elephants had access to both the indoor and outdoor areas (Table 3). The other behaviours for which a significant difference was found between the observation periods were feeding (P=0.039) and leaning while resting (P=0.047).

The proportion of time spent swaying in the focus elephant was significantly negatively correlated to the time spent resting, time

Table 5. Correlations of the factors considered most influential for stereotyping in a female African elephant assessed by Spearman's correlation coefficient.

	Temperature	Time whole group allowed together	Time of access to all enclosure areas
Stereotyping	R=-0.01	R=-0.71	R=-0.24
	P=0.967	P=0.003	P=0.394
Temperature		R=0.07	R=0.64
		P=0.800	P=0.011
Time whole group allowed together			R=0.12
			P=0.659

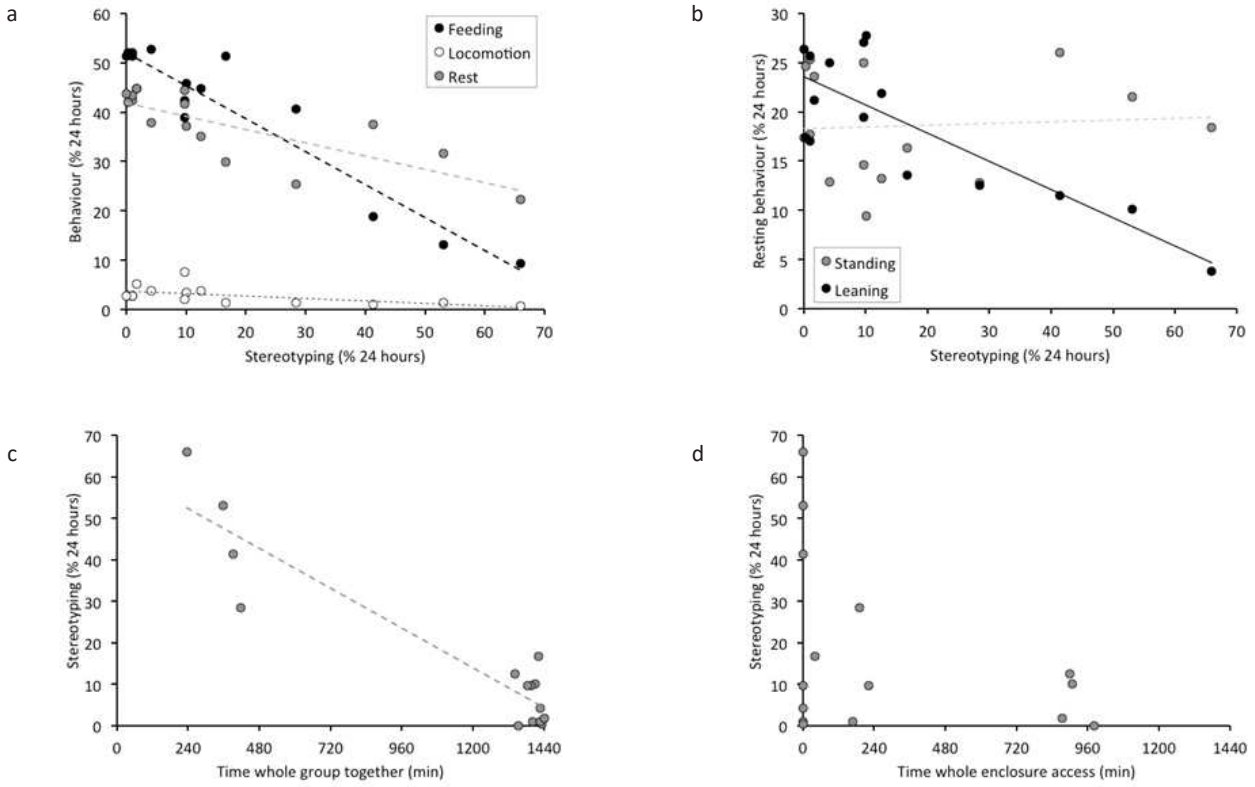

Figure 3. Correlation of daily stereotyping in a female African elephant with further behaviour categories (a), resting behaviour (b), separation of the group (c) and access to whole enclosure (d).

spent feeding, and time spent in locomotion (Figure 3a, Table 4). Differentiating the resting behaviour in more detail, the negative correlation was evident with leaning, but not with free-standing behaviour (Figure 3b, Table 4). Among the potential contributing factors to stereotyping, temperature showed no significant correlation (Table 5). There was a significant negative correlation between the time all elephants were allowed together and the time spent stereotyping (Figure 3c, Table 5), but not with the time that all enclosure areas were accessible for the animals (Figure 3d, Table 5). Correspondingly, in the General Linear Model ($F=38.274$, $P<0.001$, adj. $R2=0.84$), time with access to all enclosure areas was not significant ($F=0.169$, $P=0.688$), whereas time when all animals were allowed together was ($F=64.596$, $P<0.001$).

Discussion

The applied method of direct observation led to an extraordinary rate of successful scans (99.77%) which was distinctively higher than comparable recent studies in which elephants were categorised as “out of sight” for at least 25% of the time (Boyle et al. 2015; Williams et al. 2015). The female elephant expressed one single form of stereotypic behaviour (swaying from side to side), which is reported to be the usual case in elephants with only a minority of them showing different patterns (Greco et al. 2017). Expressing swaying on average for 17.17% of time, the amount of stereotyping exhibited by the focus elephant fell in the middle of the range reported for zoo elephants of both species, but on the upper end of the range for African elephants (Björk 2011; Braidwood 2013; Elzanowski and Sergiel 2006; Greco et al. 2017; Greco et al. 2016; Meller et al. 2007; Rees 2009; Schmid et al. 2001; Stoinski 2000; Wilson et al. 2004).

The amount of swaying in the focus elephant varied between the days and periods of observation and showed a distinct decline after Period 2 (Figure 2). This change correlated with the transfer of the elephant group to the new indoor exhibit, allowing the group to stay together during night and day time. After this period, the amount of daily swaying remained on a comparable low level during Periods 3, 4 and 5 (on average 72.8 min ± 86.98; 5.06%). A similar decrease in stereotypic behaviour after transition to an exhibit providing increased enrichment and choice to the elephants was reported for Blair Drummond Safari Park in Scotland (Braidwood 2013; Jacobs 2011; Lucas and Stanyon 2016) .

Based on our data, we could not detect any significant correlation between the elephant´s amount of swaying and ambient temperature (Table 5), which has previously been reported for the Asian species (Rees 2004). In the latter report, the author considered temperature as a confounding, rather than causing, factor for the occurrence of stereotyping. Thus, in the case of the present focus elephant, changes in the amount of swaying might be mainly caused by more influential factors than ambient temperature. Because this case report does not represent an experiment with a controlled manipulation of a specific factor, it is not possible to pinpoint a single one, even if the statistical correlations indicate that the immediate deprivation of the habitual social contact was particularly decisive in the present case. Absence of statistical significance does not mean that no effect exists, and many of the present variables (e.g. direct or protected contact, male within the group or not, different seasons, condition of joint disease) may have affected the elephant´s behaviour. To investigate the effect of all these factors, an appropriate setup would be necessary, in which they can each be correctly measured in a bigger sample size.

One important characteristic of the new exhibit at Zoo Basel is the extended feeding enrichment programme. Reduction of stereotypic behaviour in Asian elephants through extra feed supply with a higher feeding frequency has been demonstrated previously, although the effect was not consistent between individual elephants (Björk 2011; Rees 2009). Thus, a reduction in swaying since transfer to the new environment could be explained by a more diversified feeding system. This hypothesis could not be confirmed by the development of the elephant's activity budget over the five periods of observation. A continuous decline of the percentage of time spent foraging occurred in Periods 3 to 5 (Figure 2). At the same time, the amount of time spent in a leaning position steadily increased (Figure 2). According to the elephant keepers, the female had stopped exhibiting lying rest in April 2015, presumably due to degenerative joint disease. Subsequently, she suffered several bouts of falling and required assistance to get up again between 26th October 2015 and 7th January 2016 (Schiffmann et al. 2018). This episode coincided accurately with the lowest amounts of leaning and foraging in Period 2, with a peak in stereotypical behaviour (Figure 2). Assuming that lying rest is a positive and stereotyping a negative welfare indicator (Asher et al. 2015), this inverse correlation seems logical. If leaning behaviour functions as a substitute for lying rest (Schiffmann et al. 2018), increasing this behaviour might lead to an improved well-being (although still suboptimal compared to elephants having lying rest) and thus a reduction in stereotypic behaviour. During Period 2, with the highest percentage of swaying, the elephant showed a significant reduction in foraging (Figure 2). This is in accordance with Kurt and Garai (2001) and Koyama et al. (2012) who observed intense stereotypic behaviour displacing natural behaviours in captive elephants. Considering foraging and resting as natural behaviours, their negative correlation with the amount of swaying (Figure 3a) as well as the positive correlation between them corroborates this view.

Having a closer look at the circumstances during Period 2 suggests explanations for the elephant´s behaviour. During this period, the group was constantly confined indoors for the night time and separated into two pairs. Separation and restricted access to indoor or outdoor areas have both been identified as risk factors for stereotypic behaviour in zoo elephants by Greco et al. (2016). Additionally, the elephant´s preferred location for leaning while indoors, a narrow walkway, became unavailable due to the progress of the construction site. An accumulation of these factors is supposed to be causal for the intense swaying during this period. It can be discussed whether her falling bouts had a cause or effect relation with the excessive stereotypic behaviour during these months. After transferring the elephants to the new indoor exhibit, the aforementioned risk factors were eliminated and social contact was no longer restricted. GLM analysis revealed the latter as a significantly correlating factor for the amount of stereotyping (Table 5), which is in accordance with previous reports suggesting social circumstances to have strongest impact on stereotypic behaviour in captive elephants (Greco et al. 2016; Kurt and Garai 2001; Vanitha et al. 2016). Kurt and Garai (2001) as well as Vanitha et al. (2016) investigated stereotypic behaviour in captive elephants in countries of origin and suggested it to be a symptom of social isolation. This is in accordance with Greco et al. (2016), whose models for North American zoo elephants revealed the social environment as the most influential factor in predicting stereotypic behaviour rates.

Moreover, the new exhibit provides the elephants with increased spatial choice by way of free access to the indoor and outdoor areas. A positive effect of choice related to open or closed doors has been reported in zoo elephants before (Lucas and Stanyon 2016; Thomas et al. 2001) but might not be restricted to this aspect. Choice related to increased options regarding temperature regulation, access to novelty and information by visibility of keepers, visitors or other animals, might all have positive effects depending on the particular setting. In addition, the focus elephant detected opportunities to have leaning rest in her new environment during the following months (Schiffmann et al. 2018), which may have further increased her well-being. Due to the fact that swaying dropped already before the change from direct to protected contact (after observation Period 3), the impact of the management on the behaviour may have been negligible.

In conclusion, we were able to document the amount of stereotypic swaying behaviour in an elderly female African elephant during reconstruction of and transfer to a new enclosure (I). After allowing access to the new indoor area, the amount of swaying dropped dramatically. Permanent social interactions without any separation of the female elephant group, increased freedom of choice with access to indoor and outdoor areas, as well as provision of locations for leaning rest were considered the critical factors for this reduction (II). Based on these findings, we hypothesise social factors and complexity of an enclosure providing appropriate resting locations to be more relevant for the decrease of this zoo elephant´s stereotypic behaviour than exhibit size and dietary enrichment. The data from this case study of one individual are not sufficient to base the aforementioned assumption on statistical significant findings. Further research with a different setup and bigger sample sizes is required to shed more light on these interrelationships. Implementation of corresponding aspects may allow immediate and significant improvement of elephant welfare in other facilities where construction of new exhibits or a spatial expansion of existing ones is not feasible.

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